ON SHOYU

BY

T. ISONO,
STUDENT IN THE SENIOR CLASS OF CHEMISTRY,
TOKIO DAIGAKU.

6TH MONTH OF THE 11TH YEAR OF MEIJI.

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ON SHOYU.

Few things are of greater importance in Japanese cookery than the peculiar kind of liquid produced by the fermentation of beans and wheat in a saline solution. This liquid is called sho-yu, to-yu, or hishiwo, but it goes almost universally throughout the country under the name of "Sho-yu". "Sho" is derived from a word having the same pronunciation "Sho" meaning the general of an army, and the word "yu" means oil, therefore the term "Sho-yu" signifies that it is the oil which has the power of destroying the poisons of the food when it is cooked with this liquid, and resembles the general of an army who suppresses an insurrection and defends the country from invasion. It is of Chinese origin, and in that country there are a great many varieties prepared from different kinds of beans. I shall here mention some of the different kinds:—

1° To-yu is prepared by mixing 3 kin (weight) of boiled common white beans and 24 kin of wheat flour, and to each 10 kin of this mixture 8 kin of common salt and 40 kin of water are added.

2° Daidsu-sho is prepared by mixing 1 to of powdered roasted white beans and 3 to of wheat flour, and to every 10 kin of this mixture 5 sho of common salt and a variable amount of water are added.

3° Sho-to-sho is prepared by mixing together the well washed adsuki or red beans and leaving the mixture to stand for one year. Then it is mixed with salt and water and subjected to fermentation.

Other kinds of sho-yu are prepared in a similar way, the only difference being in the kind of beans used, of which there are, 4°. Yento-sho prepared from yento and flour, 5° Fu-sho prepared from wheat flour only, and lastly 6° Kan-men-sho. In all the above preparations, the mixture of beans and wheat is made into koji before being mixed with common salt and water.

The Sho-yu or to-yu above mentioned is similar to the Japanese, except that the wheat is not roasted and is more finely divided; the Japanese sho-yu therefore must be a modification of this and should be on that account called to-yu (meaning oil of beans) and not sho-yu, for this term is a general name applied to all such kinds of fermented liquid.

For the preparation of sho-yu were require two vegetable subtances viz. beans and wheat, and an inorganic body, viz. sodic chloride or common salt. I shall consider each of these necessary materials separately before speaking of the preparation of sho-yu.

Wheat. It is said that barley gives a much better taste to sho-yu than wheat, but on account of the difficulty of removing the husk from the former, the latter is almost universally used for commercial kinds. Wheat is called *komugi*, and barley is called *ō-mugi*, the term *mugi* being a general name applied to all the similar kinds of grain such as wheat, barley, rye, and oats. Its cultivation is very simple. The ground is well cultivated and manured before the seed is sown. The sowing is done in the autumn, and the plant begins to grow the following spring and ripens in the summer. All weeds must be carefully removed either by picking by hand or by ploughing. This grain is the most important part of Japanese food next to rice. The wheat used for sho-yu manufacture is a very poor kind, one sample which I analyzed contained a small quantity of oats, barley, and rice mixed with it. I therefore picked out the grains of wheat and subjected them to analysis, with the following results:—

Water	13.77 %	Cellulose	2.25 %
Starch	61.46 „	Ash	1.96 „
Dextrin	5.41 „	Extractive matter	5.75 „
Nitrogen	2.29 „	Ash of the extract	0.85 „
Fat	1.16 „		

In order to compare this wheat with other specimens I have calculated the above percentages by excluding water and by multiplying the amount of nitrogen by $\frac{100}{16}$ to get albuminous body.

I. is the sample I analyzed & II. that given in our lectures.

	I	II
Starch	71.25	68.65
Alb. body	16.67	16.25
Cellulose	4.08	3.40
Dextrine	6.27	7.00
Fat	1.34	1.95
Ash	2.27	2.75
	101.91	100.00

There is no great difference between the two analyses except in the amount of the starch. In the first analysis the sum becomes greater than 100 by 1.91 & this increase is due either to experimental errors or to the use of the approximate coefficient of $\frac{100}{16}$ in converting nitrogen into the albuminous body. However, it gives us some idea of the composition of the wheat used in manufacture of sho-yu.

Beans are almost as important vegetable products as rice and wheat. They are mostly used as food in the form of *to-fu*, which is prepared by extracting the beans with water after grinding in a stone mill; the extract is boiled, and the albuminous matter coagulated by what we call *nigari*, or a mixture of magnesic sulphate and chloride. There are seven different kinds of beans of which only three are used in the sho-yu manufacture. (a) Those generally used are the common white beans, *daidzu* or *ki-daidsu* (large yellow beans), which are sown in winter and ripen at the beginning of the autumn. (b) *Natsumame* (summer beans) so called because they ripen at the end of the summer. (c) Lastly *kuri-mame* (chestnut bean), rarely used, and so called as their taste somewhat resembles that of the chestnut. This bean is larger Beans.

than the kinds above mentioned and has a purple tinge. It is said to produce a better tasting sho-yu than any other kinds of bean but it is seldom used as it is dearer. They are sown at the end of the winter, especially along the sides of the dykes that separate the rice-fields, but also in special soils. This is done by making successive notches by means of a wooden rod, dropping 4 or 5 seeds into it, and covering with wood ashes mixed with manured soil. The following is an analysis of beans used for sho-yu manufacture. These beans cost 7 sen per sho and are mixed with a small quantity of black beans. They were dried at 100°C, powdered, and subjected to analysis:—

Starch	31.22 %	Fat	15.37 %
Dextrin	2.58 ,,	Cellulose	5.24 ,, =(100.49)
Nitrogen	(6.61) ,,	Ash	4.78 ,,
Albumenoids	41.30 ,,		

Determining the water in the original beans I found it to be 9.64 %.

I have not found any analysis in books so that I can not compare them with my result.

Common Salt.

Common salt is indispensable as an article of food in Japan as well as in all other parts of the world. There are three kinds of common salt in commerce differing in purity and in the mode of preparation.

1°. Common kind, sold in straw bags. Although slightly different in colour and purity, they are invariably contaminated with sand and pieces of straw and are not perfectly white in colour but possess a tinge of grey. This kind contains all the compounds which the sea water contains as it is obtained by merely evaporating sea water to dryness. Among the impurities, the magnesium salts are very large in amount, for when the bags are placed over a dish, after a while we find a large quantity of magnesium salt, which has deliquesced by attracting moisture from the air, within the dish. These deliquesced salts are called *ni-gari* (derived from the word *nigashi* signifying *bitter*, as the magnesium salts are bitter to the taste.) This nigari is used in precipitating *to-fu* as I stated before on page 3. This impure kind of salt is most largely

used while the other two are only used by rich men or nobles.

2°. Yaki shiô or burnt salt. This was first prepared by Totaro who lived at Minato in Sen shiu (Idzumi, now a part of Sakai ken) in the year Tenbun, about 340 years ago. He took the salt from Saiga (Wakayama-ken) and ignited it in an earthenware pot on which account he was called Tsuboziwoya (pot-salt) Totaro. The emperor of that time gave the name of Ten-ka-ichi or The First in the world to that salt as a reward. At present this burnt salt is prepared in many different places.

3°. The Kwa-yen, or flower salt, is obtained by the recrystallization of the common salt and putting into a mould resembling the plum flower whence it derived its name. It is perfectly white and has a nice taste. The best kind is called Kado-shio and is prepared at Sakai in Sen-shiu.

In Japan, salt is obtained from sea water only, although in China it is obtained from sea water, rock salt, and from salt springs. It is said that two salt springs occur in Rokuziu-rigoye, the district lying between Aidzu and Yonezawa, the diameter of these springs being only 3 to 4 shaku, but whether salt is obtained from them or not, I was not able to ascertain. Also at Noda in Sadowara, Hiuga, and at Yabuakune in Satsuma, there are salt springs from which salt is obtained, though in small quantity. In the latter district, there is a deposit of rock salt which is worked at present. Thus we see that in Japan the salt is obtained almost entirely from sea water. The most celebrated salt working districts are Ako in Harima, Kashino in Bizen, and Giōtoku in Musashi. Wakasa and Yechizen are also noted. The famous old salt working districts are Shodo island near Bizen, Tagono-ura in Suruga, Sumano-ura in Settsu, and Chigano-ura and Matsushima (this island is celebrated also for its beautiful scenery) in Ôshiu; these places are referred to in Japanese poetry, but at present they are not worked at all.

The followings are those districts celebrated for their salt:—

(1) Shimo-takayamura, Onagai mura, Otome-mura, and Minasakimura, in Usa,—Bizen. The price of the salt is 0.85 sen per sho.

(2) Imari in Hizen.

(3) Salt spring at Nodamura in Sadowara—Hiuga.

(4) Salt spring and rock salt at Yabu-Akune—Satsuma.

(5) Ako in Harima—Here the best kind of burnt salt is sold at 18.75 sen per box.

(6) Kojima at Kuzigori—Bizen. The production of one year was 809613 bags, one bag containing 5 to.

(7) Kaminoseki in Kumage, Komamatsu in Otori, and Mitaziri in Sawa—Suwo. Here the so called burnt salt or roasted salt is prepared.

(8) Miidera and Mikuzu in Wakayama—Kishiu, the production of one year amounts to 3500 koku valued at 2763.36 yen.

(9) Takashima in Itano—Awa, produces the kind called Kei-yen which costs 33 sen per box.

(10) Buyo Itano, Kotayezima, and Tachibanano-ura, in Higashi-gori the same province as the above produced in one year 1476000 bags; 44.62 sen being the cost of each bag.

(11) Sanuki produces yearly 770 700 bags each bag containg 5.2 to. Here burnt salt is also produced which costs 5 sen per bag.

(12) Noma, Hashihama, Wake, and Niihama in Iyo. Here a bag containing 2.6 to costs 12.5 sen.

(13) Sumida at Kambara--Yechigo produces annually 140 koku valued at 140 yen.

(14) Gio-toku at Katsushika—Musashi produces annually 59700 koku, 1 bag holding 6 sho costing 4.7 sen. ∴ total value amounts nearly to 50000 yen.

(15) Kashima in Hitachi produces 5500 bags.

The total amount of the salt produced by 25 villages at Nakagori and Tagori is 2829.747 koku valued at 2934 yen in one year. One bag containing 2.1 to is sold at the rate of 25 sen. Thus we see from the above that the cost of the common kind of the salt is 78 sen per koku. The largest producing district is Kuzikori in Bizen producing 404805 koku annually, the value amounting to 320000 yen.

Next comes Sanuki which produces 385350 koku annually valued at 300000 yen.

Next comes Giotoku at Katsushika which produces 59700 koku amounting is 50000 yen.

The amount produced in Ako which is so celebrated could not be found as far as my research extended—but I think it must be very large, perhaps equal to that of Bizen if not greater. According to the report of Shikamaken (the province to which Ako belongs) in the 8th year of Meiji the amount produced in the whole ken was 747393 koku which would cost about 590000 yen. But this latter amount includes many other works besides Ako. The preparation of common salt from sea water in Japan is a very rough and rudimentary process, nothing like that of the West where scientific methods are adopted to separate impurities, to save time, and to economize human labour as much as possible. Although it differs slightly in detail in different places, the principle depends upon the evaporation of sea water over sand by the sun's heat, dissolving it in fresh sea water, by which a more concentrated brine is obtained, and subsequent evaporation of the brine thus obtained by means of artificial heat. Here I shall describe, as a typical process, the preparation as carried out at Oshio in Innangori—Harima (Shikamaken).

This village is about 8 miles from Himeji and is situated near the sea coast. The process as here carried on consists of 3 stages, as follows:—

I. Preparation of a concentrated solution of the salt by evaporating the sea water over sand repeatedly and subsequent lixiviation of the sand with sea water.

II. Evaporation to dryness of the brine thus prepared.

III. Removal of the magnesium salts by leaving the evaporated mass to stand in bamboo baskets in contact with the air.

I. Preparation of the concentrated brine.

In order to effect this, what is called Shiwohama (salt bank) is made. This is constructed upon a sandy bank which is not, however, so porous as to permit the quick penetration of the water. One Shiwohama is about 118800 sq. shaku in area and is worked by 7–8 labourers. At the side of this chosen bank, a ditch is made communicating with the sea so as to convey the sea water. This ditch is provided with a tide-sluice so as to fill the ditch always with water by opening the gate when the tide is coming, and

Fig. 1.



Sprinkling the brine.

shutting it up when the tide retires. On a fine day, the workmen, balancing two buckets by means of a wooden rod, filled with the salt water from the ditch, sprinkle the water over the sand in the Shiwo-hama as uniformly as possible. Then the sand is turned over by means of bamboo forks to expose fresh surfaces as much as possible to the sun's heat. When one part is dry, another shower of salt water is sprinkled over it, and by repeating this several times, the sand becomes tolerably charged with salt, after which it is transferred to a wooden tank (Shiwo-oke) provided with a hole at the bottom and the salt is dissolved out by pouring upon it a quantity of sea water. The concentrated solution of salt comes out from the bottom and is received into another tank and then carried to the evaporating pan.

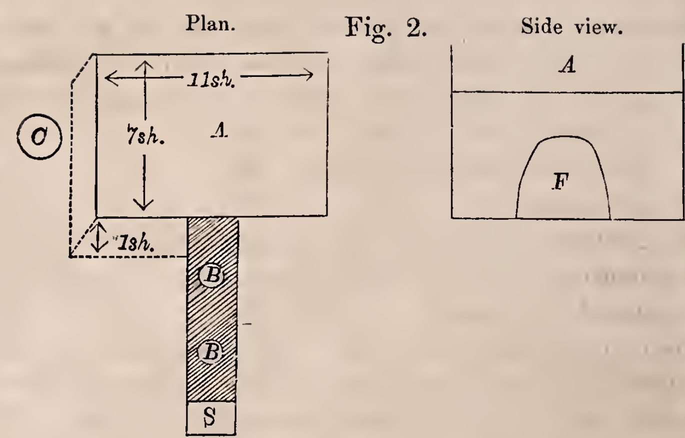
Fig. 1.



Raking the Sand.

II. Evaporation of the brine obtained by the first process. The pans and furnace used for this purpose are very much improved and seem to me the best of all the Japanese kinds. The apparatus is shown in figure 2 and consists of a large evaporating pan (*A*) 11 shaku in length, 7 shaku in width, and 1 shaku in depth; this pan is made of clay except the bottom which is

Fig. 2.



made of *awo-ishi* or *subera*, a green coloured stone. This is done by mixing the powder of this stone with the ash of pine leaves and a little sea water and making it into a kind of mortar. When it is made and dried, the whole pan is suspended by means of an iron chain from the roof of the building. The pan is provided with a fire place (*F*) which heats the bottom of the pan uniformly and the hot gas escapes through the flues in the opposite side and through the chimney (*S*). In order to use the waste heat two small pans made in the same way as the large pan are placed over the flue (*B B*). (*c*) is a drainer of the magnesium salt after evaporating and will be explained afterwards. The fuel used is a kind of coal mixed with soil which is found in the island Shodo near this place. Sometimes this coal is used alone and sometimes it is mixed with pine and other wood fuel. The brine is at first evaporated in the small pans (*BB*) and when it is evaporated to a certain consistency, it is transferred into the large pan (*A*) and fresh brine is made to fill the small pans. When the brine is evaporated to near dryness in the large pan, it is raked out in to the drainer by means of wooden spades and another charge from the smaller pans transferred to the large pan and this operation is repeated so long as the pan lasts; generally it requires repairing or renewing every 20 days.

III. The removal of a certain quantity of magnesium salts is effected by exposing to the air the salt above obtained in a large

bamboo basket placed upon a tank which receives the drained magnesium salts. The basket is called "Shitari" (drainer). When exposed, for several days, most of the hygroscopic bodies drain down through the meshes of the basket and collect in the tank. The salt thus obtained is placed in straw bags or "tawara" and sent into commerce.

During 20 days work, the amount of salt produced is about 1000 koku, commanding a price of at least 500–600 yen, The amount of coal consumed during the process costs 40 yen.

This is a brief description of the salt manufacture at Oshiō from information given to me by a friend who visited these works.

In other places, instead of using sand in the evaporation of the salt water, a layer 0.1 shaku thick of ash over the shore is used. In some favourable districts, the sandy shore is charged with the crystallized salt by the tide which wets the sand and by subsequent evaporation of the water by the sun, and the people collect this sand and treat it as usual.

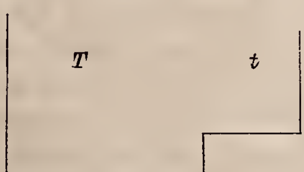
Fig. 3.



In turning over the sand to expose fresh surfaces to the drying action of the sun's heat, instead of *matsubakaki*, or bamboo fork, a rectangular board pierced at its centre with a wooden rod which acts as a handle, is sometimes used as represented in fig. 3.

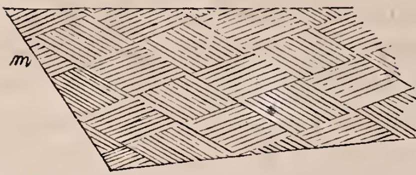
In other places, instead of using *Shiwo-oke* described in page 10, the following arrangement is used for dissolving the salted sand:—

Fig. 4. *a.*



Two holes T and t are dug in the ground (Fig. 4)., (t) is about 1 shaku deep and is covered at its mouth by means of a frame work of bamboo and twigs, and upon this a rude mat (m) is placed;

Fig. 4. *b.*



T is much deeper being 7 or 8 shaku. Upon the mat is plaeed the salt-charged sand and the salt is washed out by means of sea water which flows down into (*T*.). Of eourse, the holes are made water tight by seeuring the inside with lime mortar.

In other places, different kinds of evaporating pans are used. In one plaee is used a circular pan of sheet iron fastened together by iron pins; it is 10 shaku in diameter with a depth of two shaku. This pan at first leaks but this is soon stopped by the deposit of salt in the interstiees. When fully eharged with brine, it requires 7–13 bundles of wood for fuel to evaporate it. Another kind is a very peculiar one—At first the frame work of the pan is made with bamboo work 10 shaku in diameter and 1 shaku deep. This is on the outside and inside thiekly coated with lime prepared by burning sea shells, the lime being mixed with rice husk. This is dried and used.

The eommon salt from salt springs is obtained almost exactly as from sea water.

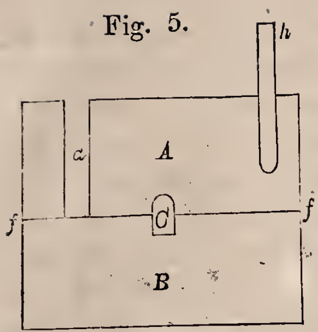
Roek salt is not purified but is powdered directly and used.

I have made one analysis of the eommon kind of salt costing 0.7—0.8 sen per sho, with the following results.

$MgSO_4$	7.51 %	$NaCl$	73.00 %
$MgCl_2$	1.74 %	Insol. matter (sand, $CaSO_4$, &c)	0.17 ,,
KCl	2.04 %	H_2O & organie matter	15.61 ,,
			100.07

Sho-yu. Although sho-yu is usually bought from the manufacturer by the eitizens, many farmers in the country make it on a small scale in their houses. The preparation of such kinds of sho-yu is slightly different from that carried out on the large seale. I shall describe here the preparation on the small scale, translating from the book called Koyeki-kokusaın-ko, by Okura Nagatsume, who says that it is more eeonomieal to make the sho-yu at home when the family consists of more than 3 persons. The process is as follows:— 6 sho of un-husked barley are roasted, and half of this is roughly ground by the

Fig. 5.



hiki-usu (which is the common apparatus for grinding flour in the family). This apparatus is represented in Fig. 5. It consists of 2 solid cylinders of sandstone about 1 shaku in diameter and 5 shaku thick, and these 2 cylinders (*A* & *B*) have very rough surfaces where they come in contact, that is on the surfaces (*f f*). The upper cylinder (*A*) is made to revolve over the lower one (*B*) on a pivot (*C*) fixed in the lower one and fitting into a hollow in the upper one. Thus on revolving the handle (*h*) by hand, the upper stone revolves upon the lower one with (*C*) as an axis. By turning this and adding barley through the hole (*a*), it is reduced to a rough powder. The barley thus treated is mixed with 6 sho of boiled beans and made into koji. This koji making can be done from June to August by placing straw mats in the corner of the house or in a cellar upon which the mixture of grains is spread in a layer about 1.5 sun thick. When the operation is performed in summer no covering is required; when it is done in autumn or winter it should be covered with straw mats in order to keep it warm. A small quantity of *susuki* (a kind of reed) should be placed over the grains before being covered with matting. Also if the grains are sprinkled over with the ash of "sugi"-leaves, it gives better koji and with greater ease. Generally the koji making is performed in July; and in this case, if the mixed grains are placed on the mat without any covering, after three days we shall find the grains covered with a white mould; then we break down the masses with the hand and leave for two days when it is completely converted into koji. The mass is again broken down by hand, dried in the sun, and preserved.

To 12 sho of the koji thus prepared, 3 sho of common salt, and 18 sho of water are added, and mixed in a wooden tank. Sometimes 21 sho of water are added but this gives sho-yu of inferior taste; for the best sho-yu 16.2 sho to 16.8 sho of water are used. During the standing of the mixture, it should be frequently stirred

Fig. 6.

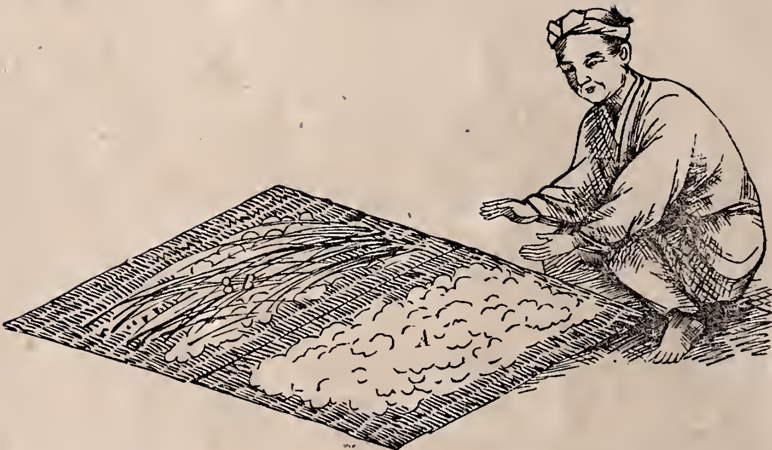


Fig. 7.



Fig. 8.



Fig. 9.



by *maze-bo* or *kai* (*A*) Fig. 9 page 15. The *kai* consists of a circular board 1 sun thick and 3.5 sun in diameter with a handle of bamboo. (*B*) is a tank containing moromi, or the unfiltered sho-yu, and is being stirred with a kai (*A*). (*C*) is also a tank containing moromi and is covered with mats when the mass is not stirred. After 20 days, *amazake* (sweet saké) is added to the moromi. This *amazake* is prepared by mixing 2 sho of "sake koji" and 1.5 sho of steamed rice and then leaving the mixture to stand for one night. Instead of *amazake*, "sake" residue made into a milk with water may be added, or the product formed by boiling together 1.5 sho of rice and 2 sho of koji. In this way, the taste of the resulting sho-yu becomes much better. After 75 days from the first starting, the moromi can be used for extracting sho-yu. This is done by immersing the bamboo basket (*c*) Fig. 8 into the tank containing the moromi and then transferring as much liquid as we want at that time, into another tank. When no more clear liquid filters into the basket, the residue is introduced into a linen bag and the juice squeezed out. From the residue, we can get a second amount of sho-yu of inferior quality by mixing it with 6 sho of common salt and 1 to of water and leaving it for 40–50 days, when the sho-yu can be obtained by treating as before. There is a prejudice among the people against home made sho-yu as it does not present the deep brown colour of the commercial kind, but this colouring can be given by the following process. Raise the sho-yu to the boiling point, and keep it in a well closed tank till April of the following year, and again raise it to boiling; in this way not only is the deep brown colour produced, but also it will keep longer, producing no mould in the rainy season.

Extract from Sangio-bukuro.

Another method is described in the book called Bankin-sangio-bukuro. 1 koku of wheat is roasted, roughly ground, and mixed with 1 koku of beans (boiled) and made into koji. When this is done it is mixed with 2 koku of water and 8 koku of common salt, and the mixture is stirred every day with the *kai* and left for at least 60 days. The manufacture is best conducted during the summer, finishing at the end of the autumn. When filtered it gives about 2.6–2.7 koku of sho-yu. This sho-yu is called Ki-

sho-yu, (nascent sho-yu); it has a very nice taste and does not produce any mould during the hottest summer. However if such sho-yu were sold by the maker, it would be a loss to him rather than a gain. For this reason, 3 kuamme of "sake" residue are boiled with 3 to of water and 3 sho of common salt until the whole assumes a thick consistency, when cool, add 4 or 4.5 sho of this *modoshi* to 1 to of moromi without first filtering, and afterwards subject it to filtering. There is another method of preparing modoshi. 2 sho of mochi-gome are steamed and converted into koji and then boiled with 3 sho of salt and 1 to of water and used in the proportion above given. By this treatment, the sho-yu acquires a very good colour and taste, but, unlike kizio-yu, it is covered with mould in the summer, especially during the long rainy season. The process of taking a second quantity of sho-yu from the residue is always performed in winter. To the residue from which 2 to of sho-yu is obtained, (or about 1.08 to of the residue), add 1 to of water and 3 sho of salt; mix well, and leave to stand for about 30 days and then it can be filtered. To get better sho-yu from the residue, 3 sho of koji are added to the above mixture and the whole then filtered. The water used for this purpose should be boiled for a short time.

For sho-yu making, those kinds of salt called Ako-jiwo, Mugiwara-jiwo, and Shimajiwo are the best suited.

There is another kind of sho-yu called Tamari-jiwo-yu which is prepared with koji made from barley and black beans. 1 to of barley is roasted, ground, and mixed with 1 to of black beans which have been well boiled, and the whole converted into koji. To 2 to of the koji thus prepared, 8 sho of water and 2.5 sho of salt are added, treated as before, and after about 75 days it is filtered for use. This sho-yu has a much better taste than the common kind, but it costs more.

The largest sho-yu producing district is Sakai, in Idzumi, where three kinds are made, classified according to their quality and taste. Those which come from Yatsuhama in Bizen, Ôzaka, and Shirako and Matsuzaka in Ishe are black bean sho-yu, or tamari-zio-yu, and are esteemed as the best qualities; in these places also the common sho-yu is esteemed. Nagoya, in Owari, and Uyeda, in Shinano, are also

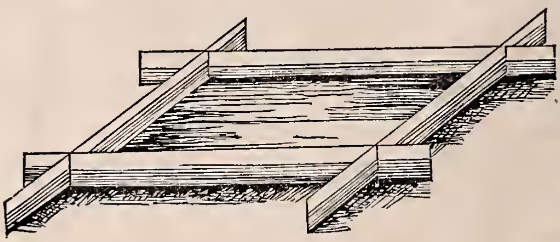
large sho-yu producing places. The sho-yu commonly used in Tokei comes from Odawara in Sagami, from Furukawa, from Fujioka in Zio-shiu, and from Noda in Shimôsa and from other districts near it—these kinds of sho-yu are called Jimawari-shoyu.

Sho-yu making at Takino gawa,—Oji.

In this factory 25 koku of sho-yu koji, 55 bags, or 11 koku of salt, and 25 koku of water are mixed together. At first that quantity of salt is dissolved in the above quantity of water and the liquid raised to boiling; when the brine has cooled, the koji is added, and the whole kept in a large tank. It is stirred by means of *kai* generally four times a day and sometimes oftener, according to the amount of effervescence produced. Therefore, in summer it is stirred up oftener than in winter and is thus kept for three years. Then it is filtered through a filter press without adding any amazake or honey previously.

Sho-yu koji is prepared by mixing together equal volumes of beans (boiled) and wheat (roasted and ground), and spreading one sho of this mixture over the "*hiro-buta*", a very shallow wooden box

Fig. 10.



(Fig. 10) 2 shaku long, 1 shaku wide, and 2 sun high. Numbers of these boxes are placed on the shelves of the "muro", a closed apartment with thick walls, usually covered with straw to prevent the radiation of heat as much as possible. This apartment is at first warmed with a charcoal fire, and when the proper temperature is obtained, the fire is removed and the mixture left for about 24 hrs., during which time it is often stirred up so as to break down the mass as much as possible. When finished it is removed from the apartment and used. Another charge of hirobuta is

introduced into the *muro* and this time no charcoal fire is necessary, as the apartment is already warmed by the heat produced by the former koji.

From the above quantity of moromi, 30 koku of sho-yu are obtained, and it is called *rokubu-de* or 60 % produce. From the residue, a second crop of sho-yu is obtained by mixing 1 koku of the residue with 8 to of water and 3.6 to of salt.

Here two kinds of sho-yu are sold—*a*° 12.5 sen per sho and *b*° 9 sen per sho.

As the final result 15 koku of residue is obtained which is sold as manure.

Sho-yu making at Osaka.

This factory is one we visited, and in which we obtained some information from the workmen.

Here koji is prepared in a similar way to that above described except that it is started by adding common rice koji, and without using the charcoal fire for warming the muro.

The koji is then mixed with brine containing about 0.4 sho of salt in one sho, in the proportion of 1 koku of koji to 1-1.5 koku of this brine according to the kind of sho-yu to be produced, but generally 1.4 koku is used. This mixture is placed in a large tank (capable of holding 20-24 koku) and left in that way at least for 20 months, or for two summers as the workman says. The quality of the sho-yu becomes improved as time elapses, and that which remains three years is highly esteemed for its taste and flavour. During the fermentation, it must be stirred twice a day, and during the hot season especially, the solid mass floats on the surface, supported by the carbonic acid evolved, and must be carefully broken up by stirring. When the moromi has stood sufficiently long, it is filtered as usual by means of the lever press. Before filtering, it is customary to add 10 kin of honey to 1 koku of moromi, or instead of it, a kind of amazake is generally added, which is prepared by mixing together 1 koku of rice koji, 0.7 koku of water, and 0.1 koku of boiled rice, and boiling the mixture for 2 hrs.

The residue is used for producing a second amount of sho-yu by adding 0.8 to of salt water to 40 kwamme of the residue. The second residue is sometimes used to get a third crop of sho-yu.

Of course the second and third sho-yu are of very inferior quality, and it is by mixing together first, second, and third sho-yu in different proportions that the different classes of sho-yu used in commerce are produced. The first residue is sometimes sold for food, but the last residue is always sold for manure at the rate of 5 sen per 1.7 koku. From 1 koku of the moromi, 10 kwamme of residue are obtained after the first pressing, 3.5 kwamme after the second, & 3.4–3.3 after the third. Moromi can be kept for any length of time without becoming foul, but sho-yu can be kept only for a short time, and keeps better if it is preserved in closed vessels. Sho-yu as it is filtered contains a small amount of suspended matter which is removed by leaving it to settle in a large tank for two days, and tapping the residue by opening the hole in the bottom of the tank, thus leaving the clear sho-yu behind. That which comes out from the bottom is again subjected to pressure, together with a fresh quantity of moromi. The better kinds of sho-yu become sour by putrefaction, and the worse kinds bitter, but these changes can be prevented in some way which is kept secret. The head workman is called, as in sake brewing, to-ji and receives about 40–60 yen.*

Analysis. I obtained three samples of moromi from the works at Ozaka which we visited; (*a*) which had stood only 3 months, (*b*), 10, months, and (*c*), 20 months. The method of analysis was as follows:—Weigh the bottle containing the moromi, which gives the combined weight of bottle and moromi. Filter the moromi by means of a filter pump into a litre flask whose weight is known, until no more drops of sho-yu come out. Now weigh the litre flask and sho-yu. Deducting the weight of the flask from the last weight I get the weight of sho-yu filtered. Determine the sp. gr. of the sho-yu by means of sp. gr. bottle. Now wash the residue with cold water and receive the filtrate in the litre flask which contains the sho-yu, until it comes to the mark. Weigh the dried bottle which contained moromi, and deducting this weight from the weight of bottle and moromi previously obtained, I get the weight of moromi which

* In this work as well as in all other places, the filtered sho-yu is raised to incipient boiling before it is sent into commerce.

I am going to analyze. Now determine the weight of the litre flask which will give the weight of the flask, sho-yu previously filtered, soluble substance after washing, and the weight of water used for washing. Subtracting the weight of the washings (which can be calculated easily, for we know the weight and sp. gr. of sho-yu, from which we can find its volume. 1000 c. c. minus this volume would be the volume of the washings in cub. centimeters or weight in grammes.) from that of the litre flask we get the total amount of sho-yu from the given weight of moromi, and the difference between this weight, and that of the moromi taken, will be the solid residue, or sho-yu-kasu. In the filtrate or diluted sho-yu I determined the following substances :—

1°. Total solids by evaporating 25 c. c. of the solution over the water bath and weighing the residue dried at 100°C.

2°. Ash, by igniting the total solids.

3°. Chlorine, by dissolving the ash in water and diluting to 250 c. c. and then taking 25 c. c. and determing by means of argentic nitrate.

4°. Glucose. Take 50 c. c. of the solution and neutralize the acids with sodic carbonate. Filter from the precipitated phosphates of calcium and magnesium, and make up the filtrate to 250 c. c. Take 50 c. c. of this solution and determine by means of Fehling's solution.

5°. Dextrine, by boiling the solution (50 c. c.) with dilute sulphuric acid of about 2 % strength for 8 hrs. in a closed bottle. Neutralize the acid with sodic carbonate, filter, and make up to 250 c. c., then determine the total amount of glucose and subtract the original glucose.

6°. Alcohol and volatile acid. Take 250 c. c. of the solution and distil to about half its volume. Make up the filtrate to 250 c. c. Determine its sp. gr. by the hydrometer and from the tables determine the percentage of alcohol by weight. After the alcohol has been determined, take 50 c. c. of the distillate and determine the acid by means of a standard solution of ammonia, and calculate as acetic acid.

7°. Fixed acid. Determine the total amount of acid in 50 c. c. of

the original solution, and deduct the volatile acid from this, the remainder being calculated as sulphuric acid. For if we know afterwards what is the fixed acid, we can soon calculate its amount from the corresponding sulphuric acid.

8°. Nitrogen was determined by taking a known weight of the total solid residue (.4 gr. about) by means of Dumas' method.

In the residue, I have determined :—

1°. Ash, by igniting.

2°. Starch as in 4°.

3°. Nitrogen as before.

I calculated these three substances upon the dried residue. By the above method I obtained the following results, (1) representing that of 3 months sho-yu, (2) 10 months, and (3) 20 month :—

	(1)		(2)		(3)	
Sp. gr.	1.21		1.19		1.20	
Sho-yu (before washing)	39.31 %	43.86	37.34 %	61.30	37.51 %	60.19
Increase by washing	4.55 ,,		23.96 ,,		22.68 ,,	
Residue	55.14 ,,		38.70 ,,		39.81 ,,	

Composition of filtrate :—

	(1)	(2)	(3)
Total solid	46.27 %	34.66 %	36.03 %
Ash	26.94 ,,	21.21 ,,	22.75 ,,
Chlorine	14.42 ,,	10.72 ,,	11.64 ,,
Glucose	12.09 ,,	0.67 ,,	0.42 ,,
Dextrin	4.14 ,,	3.83 ,,	3.34 ,,
Alcohol	4.61 ,,	.85 ,,	.92 ,,
Volatile acid (acetic)	.11 ,,	.20 ,,	.22 ,,
Fixed acid (SO_4)	.21 ,,	.67 ,,	.82 ,,
Nitrogen	0.30 ,,	1.33 ,,	1.44 ,,

The composition of the residue was as follows :—

	(1)	(2)	(3)
Starch	24.77 %	15.70 %	14.01 %
Ash	29.51 ,,	25.52 ,,	26.69 ,,
Nitrogen	6.78 ,,	5.25 ,,	4.88 ,,

As I have observed, sho-yu deepens in colour from (1)—(3) and the amount of gas evolved is greater. I have also analyzed another sample of sho-yu already filtered for sale and which came from Noda in Shimôsa. This shoyu is called Kikko-man and is the best that can be found in Tokio, and costs 20 sen per sho. The result is as follows :—

		(4)		in a liter.	
	Total solid	35.17 %	or	421.706	grms.
Sp. gr. = 1.199	Ash	14.66 ,,	,,	175.864	,,
	Chlorine	7.84 ,,	,,	94.001	,,
	Glucose	4.44 ,,	,,	53.226	,,
	Dextrine	4.56 ,,	,,	54.710	,,
	Alcohol	.13 ,,	,,	1.650	,,
	Vol. acid	.16 ,,	,,	1.920	,,
	Fixed ,, (SO_4)	1.08 ,,	,,	13.034	,,
	Nitrogen	1.43 ,,	,,	17.208	,,

Now what is to be inferred from the above analyses? In the first place there is a slight, though not very decided, diminution of sp. gr. from the younger sho-yu to the older ones. The soluble matter also increases from the younger toward the older. Glucose is very large in (1) and suddenly diminishes in (2) and in (3). Dextrin unlike glucose gradually diminishes from (1) to (3). Also alcohol suddenly diminishes from (1) to (2) and (3). On the other hand the acid, both fixed and volatile increases from (1) to (3), as also the amount of nitrogen. I can not, however, compare these three samples exactly, for they are not made from wheat and beans of exactly the same composition, and in exactly equal proportions, but I can get a general idea. In the residue, we have seen that the starch diminishes suddenly from (1) to (2) and (3) and there is also a gradual decrease of nitrogen.

Thus we see that during the first stage of the sho-yu fermentation, there is an alcoholic fermentation, as I found a large amount of alcohol in (1), but as it is exposed to the air, it seems to take up from it the acid ferment, and in the older one there is more of acid than alcohol. The disappearance of the alcohol in the older one is perhaps owing to oxidation into acid. Although the glucose diminishes very much in the old sample by fermentation, the dextrin as it ferments very slowly does not present any sudden change or diminution in the three samples. The albuminous matter of the beans and wheat seems to become soluble, being decomposed into more simple bodies during the fermentation. As the difference between (1) and (2) is so remarkable, and that between (2) and (3) is only very slight, we see that the greatest change

takes place between the third and tenth months while there is a large amount of glucose, but as the glucose is consumed, or rather fermented into acid and alcohol and only the dextrin remains, there is but a slight further change.

In preparing koji, we have already seen that the wheat is roasted previously, and it is probable that the object of this roasting is to convert the starch into dextrin so as to make the sho-yu more dextrinous, while the fermentation seems mostly to be performed by the glucose, formed by the decomposition of the starch present in the beans. Also there is another object of roasting, that by this means torrefaction products are formed which give a peculiar flavour and a dark brown colour to the sho-yu. However the colour is also partly due to the boiling after filtration. The object of boiling is also to destroy the ferments.

The amount of starch in the residue of the 20 months sho-yu (which is sufficiently old to be used) is about 14 % and therefore a second quantity of sho-yu can be obtained from it; but as the dextrin of the roasted wheat has been already taken up by the first, the second sho-yu must contain very little dextrin, thus making it much inferior. If the manufacturer were acquainted with the chemical changes which beans and wheat undergo, and the composition of his product, he could improve the quality of the second yield by adding dextrine; unfortunately he, as well other manufacturers in Japan, is quite ignorant of what he is operating upon; however, as science is rapidly advancing in this country, I hope, in course of time, that this process will be improved and made more scientific, like that of brewing in the West.

If we compare the analysis of the 20 months sho-yu (3) with that of Kikko-man (4) a commercial one, the most striking difference is in the large amount of glucose contained in the latter. This and other differences, such as in the amount of dextrin and chlorine, are due to the addition of *amazake* before stated. Also we find that the amount of acid in the latter is much greater, which is probably due to the decomposition of glucose. Thus from this circumstance we can tell why the Kishibori sho-yu (prepared without adding *amazake* before filtering) lasts longer than the common or com-

mercial sho-yu, for in the former there is very little sugar while in the latter there is a great deal, which of course, would soon be converted into acid ; however it is true that the latter has the better taste.

From these facts I have drawn the following conclusions :— Conclusion

1. Sho-yu is a deep brown, saline, saccharine, dextrinous, and faintly acid liquid with a sp. gr. of about 1.20.

2. The amount of acid increases as it becomes older while the amount of glucose diminishes.

3. The amount of glucose in common sho-yu is much greater than in Kishibori. This increase gives a better taste but it makes it more readily decomposable.

4. During the preparation of sho-yu the decomposition of the materials is rapid in the first stage, or during the first 10 months, but during the next 10 months and afterwards, the change or decomposition goes on very slowly.

5. The amount of nitrogenous matter becomes greater as the time increases.

6. The amount of starch in the residue after 20 months is about 14%, and can be used for producing a second yield of sho-yu.

7. Sho-yu is not injurious when used for food. As it contains a large amount of nitrogenous matter, it would give up that nitrogenous body to other food when cooked with it.

8. Of the three materials used, the most active are the beans which give nitrogenous substances, and the wheat, which affords dextrin especially, the salt being only used for giving to it a saline taste.

9. The sp. gr. of sho-yu diminishes slightly with age.

I have omitted to say that the quality of the water used, does not effect that of the sho-yu produced, according to information given by the Toji at Osaka.

P + Cl 3

= H_3PO_4 + 3HCl

HNO_3

H_3

H_2 =